CHAPTER

5

FLOPPY DRIVES

In this chapter, you will learn:

- How data is stored on floppy disks
- How to use DOS and Windows commands to manage disks
- How to replace or install a disk drive
- About removable drives

We now move from the system board and memory to our first encounter with secondary storage: floppy drives and removable drives. You will learn how data is stored on a floppy disk, how to manage that data, and how to install a floppy disk drive on a PC. Although many have predicted that floppy drives will become obsolete, their convenience and availability, the low cost of disks, and their proven usefulness and dependability have solidly rooted them in the marketplace and on almost every personal computer system.

Most of the concepts about secondary storage examined in this chapter apply to your study of hard drives in Chapters 6 and 7. In addition to discussing floppy drives and their support, this chapter serves as a foundation for the next two.

Recall that memory is organized in two ways: physical (pertaining to hardware) and logical (pertaining to software). Similarly, data is stored on a secondary storage device physically and logically. Physical storage involves how data is written to and organized on the storage media, while logical storage involves how the OS and BIOS organize and view the stored data. This chapter explains first how data is physically stored on a floppy disk and then how the OS logically views the data.

Introduction to How Data Is Physically Stored on a Disk

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Years ago, floppy drives came in two sizes: 5¼ inches and 3½ inches. Today, new computers are equipped with only 3½-inch drives. However, because some computers still have 5¼-inch floppy disk drives, this section refers to 5¼-inch disks as well. Although they are larger, 5¼-inch disks do not hold as much data as 3½-inch disks because they do not store data as densely. Table 5-1 summarizes the capacity of the four common types of floppy disks. The 5¼-inch double-density disks and the 3½-inch extra-high-density disks are hardly ever seen; most disks today are 3½-inch high-density and hold 1.44 MB of data.

Table 5-1 Floppy disk types

Type	Storage Capacity	Number of Tracks per Side	Number of Sectors per Side	Cluster Type
3½-inch extra-high-density	2.88 MB	80	36	2 sectors
3½-inch high-density	1.44 MB	80	18	1 sector
3½-inch double-density	720K	80	9	2 sectors
5¼-inch high-density	1.2 MB	80	15	1 sector
5¼-inch double-density	360K	40	9	2 sectors

Regardless of disk size and density, the physical hardware used to access a disk looks and works much the same way. Figure 5-1 shows a floppy disk drive and connections. The data cable leaving the floppy drive leads to a controller for the drive on the system board. In older computers, the controller board was plugged into the expansion bus in an expansion slot. The board communicated with the CPU, passing data to and from the floppy disk. These controller boards were called I/O cards, and often served multiple functions, having connections for a hard drive, floppy drive, and serial and parallel ports. You still see some today, so they are covered in this chapter. Today, the controller is built into the system board so that the data cable goes directly from the drive to the system board.

A floppy drive is connected to either the controller card or system board by a 34-pin data cable. The cable has the controller connection at one end and a drive connection at the other. A second drive connection is placed in the middle of the cable to accommodate a second floppy drive. Having two drives share the same cable is a common practice for floppy drives as well as hard drives and CD-ROM drives.

Floppy drives receive power from the power supply by way of a power cord. The power cord plugs into the back of the drive and has a smaller connection than the power cord for other drives in the system.

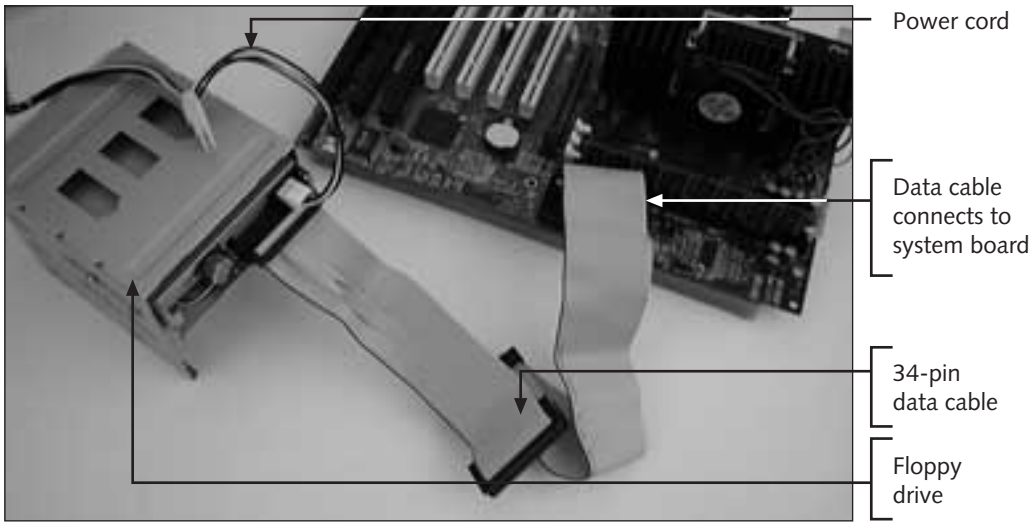

Figure 5-1 Floppy drive subsystem: floppy drive, data cable, and power connection

How Data is Physically Stored on a Disk

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Floppy disks, no matter what density or size, store data in much the same way. When first manufactured, disks have nothing written on them; they are blank sheets of magnetically coated plastic. Before data can be written on the disk, it must first be mapped in concentric circles called **tracks**, and in pie-shaped wedges called **sectors** (see Figure 5-2). This process of preparing the disk to receive data is called **formatting** the disk. Figure 5-2 shows a formatted 3½-inch double-density floppy disk. According to Table 5-1, there are 80 tracks or circles on the top side of the disk and 80 more tracks on the bottom. The tracks are numbered 0 through 79. Each side of the disk has 9 sectors, numbered 1 through 9. Although the circles or tracks on the outside of the disk are larger than the circles closer to the center, all tracks store the same amount of data. Data is written to the tracks as bits, either a 0 or 1. Each bit is a magnetized, rectangular-shaped spot on the disk. Between the tracks and spots are spaces that are not magnetized. This spacing prevents one spot from affecting the magnetism of a nearby spot. The difference between a 0 spot and a 1 spot is the orientation of the magnetization of the spot on the disk surface.

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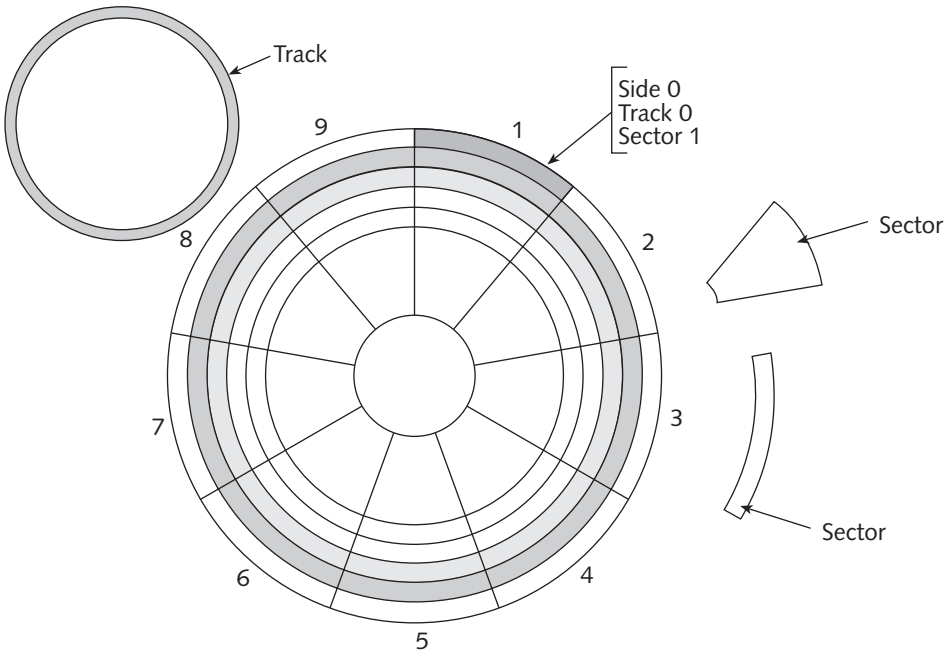

Figure 5-2 3½-inch double-density floppy disk showing tracks and sectors

Data is written to and read from the disk via a magnetic **read/write head** mechanism in the floppy drive (see Figure 5-3). Two heads are attached at the end of an actuator arm that freely moves over the surface of the disk. The arm has one read/write head above the disk and another below the disk. Moving in unison back and forth across the disk, the two heads lightly touch the surface of the disk, which is spinning at either 300 rpm (revolutions per minute) or 360 rpm, depending on the type of disk. (Note that the read/write heads of a hard drive never touch the surface.) Data is written first to the bottom and then to the top of the disk, beginning at the outermost circle and moving in. Eraser heads on either side of the read/write head, as shown in Figure 5-4, ensure that the widths of the data tracks do not vary. As the data is written, the eraser heads immediately behind and to the sides of the write head clean up both sides of the magnetized spot, making a clean track of data with no "bleeding" from the track. The magnetized area does not spread far from the track. All tracks are then the same width, and the distance between tracks is uniform.

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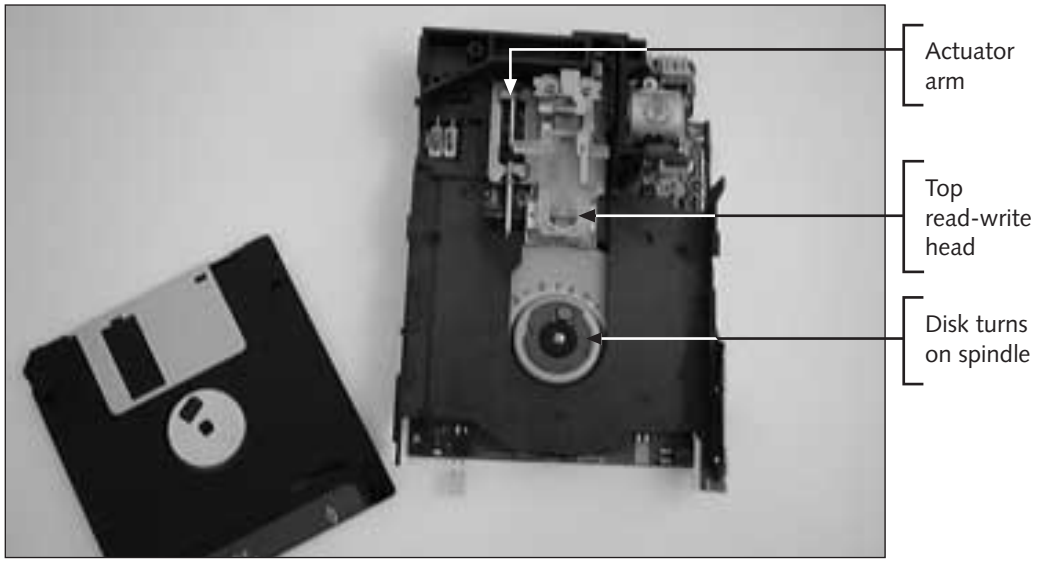

Figure 5-3 Inside a floppy disk drive

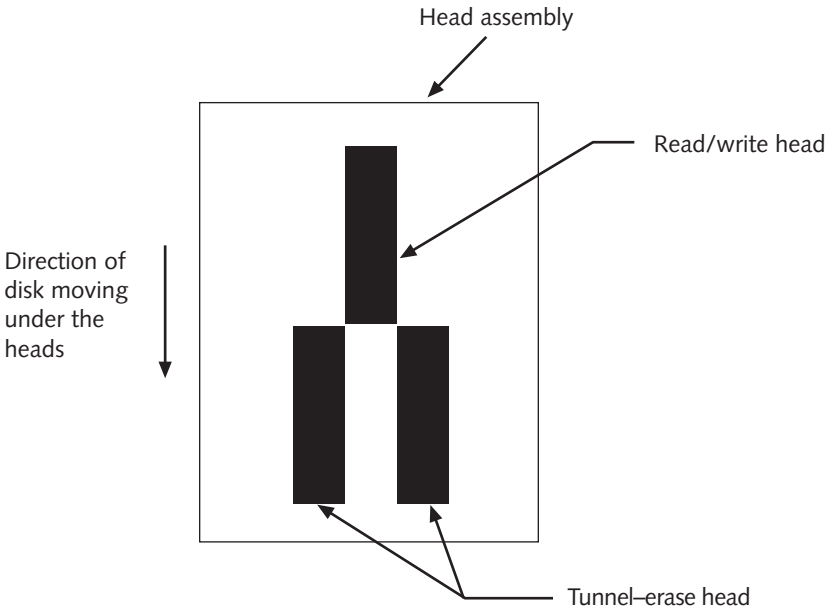

Figure 5-4 Uniform track widths are created by floppy drive read/write heads as the center head writes data while the two tunnel-erase heads clean up from behind

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The disk is actually a piece of Mylar similar to that used for overhead transparencies. Covering the surface of the Mylar is a layer of either cobalt oxide or iron oxide (rust) that can hold a magnetic charge. Some disks use another layer of Teflon to protect the oxide layer and to allow the read/write heads to move more smoothly over the surface. During formatting, the tracks are created by laying down a repeating character, the 3 (division) symbol in ASCII code, which is hex F6 or 1111 0110 in binary. The tracks are divided into sectors, and the sector that starts a new track is marked with a designated code. For 3½-inch floppy disks, the sector address mark written on the disk during formatting marks the beginning sector. After formatting, actual data is written on the disk by overwriting the F6h patterns on the tracks.

The different disk types use varying degrees of magnetic strength when data is written to a disk or when a disk is formatted. For example, a 3½-inch high-density disk can hold more data than a double-density disk because the data is written closer together. Data on the high-density disk is recorded at about twice the magnetic strength as data on the double-density disk. The high-density disk surface is not as sensitive to a magnetic field as the double-density is and therefore can handle data written to it with double the magnetic strength.

Many users have discovered that the less expensive double-density disks can be formatted as high-density, and that data can be written to the disk. Beware! Don't trust that disk with important data. The surface of a double-density disk is more sensitive to the magnetic field, and eventually the magnetic spots on the disk will affect each other, corrupting the data. The life span of an incorrectly formatted disk is very short. For this reason, always format a disk using the density for which it was manufactured.

When data is read from the disk surface, the read/write head changes roles. It passes over a track, waiting for the right position on the disk to appear. When the correct sector arrives, the controller board opens a gateway, and the magnetic charge on the disk passes voltage to the read/write head. The voltage is immediately amplified and passed to the controller board, which in turn passes the data to the expansion bus.

How Data is Logically Stored on a Disk

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In Figure 5-2, the part of a track that belongs to a single sector is marked; this segment of one track is also referred to as a sector. You can see that "sector" has two meanings: it describes the entire pie-shaped wedge on one side of a disk, as well as the single segment of one track or circle that falls within the wedge. In most of our discussions, sector means the segment of one track, unless we specify that we mean the entire wedge. A sector, or a segment of a track, as shown in Figure 5-2, always holds 512 bytes of data. This is true for all floppy disks, no matter what size or density. You will learn in Chapter 6 that this is also true for hard drives.

"Sector" refers to how data is physically stored on a disk, while "cluster" describes how data is logically organized. The BIOS manages the disk as physical sectors, but the OS considers the disk only as a long list of clusters that can each hold a fixed amount of data (see Figure 5-5).

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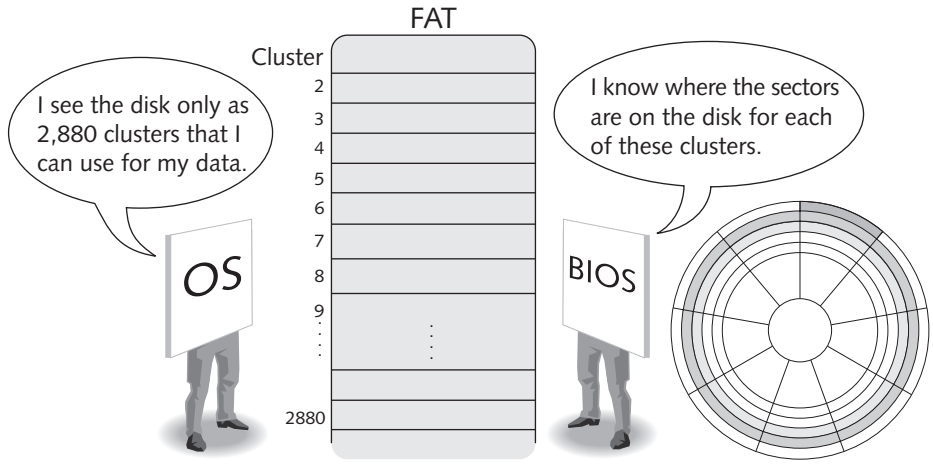

Figure 5-5 Clusters or file allocation units are managed by the OS in the file allocation table (FAT), but BIOS manages these clusters as one or two physical sectors on the disk

The OS reads data from and writes data to a disk in fixed-length chunks called clusters—a **cluster** is therefore the smallest unit of data that can be read from or written to a disk at one time. Because the OS manages a file on the disk as a group of clusters, a cluster is also called a **file allocation unit**. The OS sees a disk as a long list of clusters, or file allocation units, and keeps that list in a table called the **file allocation table** or **FAT**.

Look at a single track on the disk in Figure 5-2 to see how clusters relate to sectors. Recall that there is a matching track on the bottom of the disk. The sector directly underneath the top sector also holds 512 bytes of data. It is written to and read from at the same time as the top sector. These two sectors together make up one cluster. On the 3½-inch double-density floppy disk in Figure 5-2, each track has 9 sectors, and each side of the disk has 80 tracks. The top side has 80 × 9, or 720 sectors, and so does the bottom. Because each cluster has two sectors, the disk has 720 clusters. Each cluster holds 512 bytes × 2 = 1,024 bytes of data. One disk has 1,024 × 720 = 737,280 bytes of storage space. Divide this number by 1,024 bytes per kilobyte and you see that the storage capacity is 720 kilobytes.

Table 5-1 shows that a 3½-inch high-density floppy disk has 80 tracks and 18 sectors per track on each side. Each side has 80 tracks × 18 sectors, or 1,440 sectors. This type of disk has only one sector per cluster, making 1,440 × 2 sides, or 2,880 clusters. Because each cluster holds 512 bytes (one sector) of data, a 3½-inch high-density floppy disk has 2,880 × 512 = 1,474,560 bytes of data. Divide this number by 1,024 to convert bytes to kilobytes. The storage capacity of this disk is 1,440 kilobytes. Divide by 1,000 to convert kilobytes to megabytes, and the storage is 1.44 MB.[1]

[1] There is a discrepancy in the computer industry regarding the definition of a megabyte. Sometimes 1 megabyte = 1,000 kilobytes; at other times, we use the relationship of 1 megabyte = 1,024 kilobytes.

The Formatting Process

The formatting of all disks is similar, no matter what size or density. During formatting, the Windows 9x or DOS FORMAT command without added options performs the following steps:

- Creates the tracks and sectors by writing tracks as a series of F6s in hex and, as necessary, writing the sector address mark to identify the beginning sector on a track
- Creates the master boot record (discussed below)
- Creates two copies of the file allocation table (FAT) (discussed in detail below)
- Creates the root directory

These basic steps are described in detail next. Later in this chapter you will learn how to add options to the formatting process.

Creating the Tracks and Sectors

The FORMAT command is a DOS and Windows 9x command that prepares a disk for use. The first step in the formatting process erases any data on the disk. In its simplest form, without adding any parameters, the FORMAT command always overwrites the data with the F6h character.

The Master Boot Record

During formatting, DOS or Windows 9x prepares the disk so that you can use it to read and write data. DOS and Windows 9x prepare a disk the same way. For the purposes of this discussion, you can think of Windows 95 as DOS 7 and Windows 98 as DOS 7.1.

At the beginning of each floppy disk, the first sector contains basic information about how the disk is organized, including the number of sectors, the number of sectors per cluster, the number of bits in each FAT entry, and other basic information that an OS or BIOS needs to read the data on the disk. This information is collectively called the **master boot record (MBR)**. At the end of the MBR is a small program that can be used to boot from the disk. Table 5-2 shows the layout of the MBR and its contents. The MBR, sometimes called the DOS boot record, indicates which version of DOS or Windows was used to format the disk, and is always located at the beginning of the disk at track 0, sector 1 (bottom of the disk, outermost track). This uniformity of layout and content allows any version of DOS or Windows to read any disk. A floppy disk has only one boot record, but a hard drive has at least two. On a floppy disk, the master boot record and the DOS boot record are the same record. On a hard drive, they are two different records, each with a different purpose. You will learn more about this in the next chapter.

Table 5-2 Contents of the master boot record

Bytes per sector
Sectors per cluster
Number of FATs
Size of the root directory
Number of sectors
Medium descriptor byte
Size of the FAT
Sectors per track
Number of heads (always 2)
Number of hidden sectors
Program to load the OS

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The ninth item in Table 5-2 is the number of heads. A head refers to the read/write head that is a part of the physical components of the drive. Because the disk always has only one top and one bottom with a read/write head assigned to each, the number of heads is always two. The last item in Table 5-2 is the program that loads either DOS or Windows 9x. Some disks are bootable, meaning that they contain enough DOS code to load the OS—whatever it may be—into memory and to boot to the A or B prompt, depending on which drive contains the floppy disk. In Chapter 1, you learned that to make a disk bootable, it must include certain parts of the OS. For DOS, these parts are two hidden files and COMMAND.COM. These files can be loaded on the disk when it is formatted, or they can be loaded with the DOS SYS command. When Windows 9x creates a system disk (that is, a bootable disk), it copies COMMAND.COM and two hidden files, IO.SYS and MSDOS.SYS, to the disk to make the disk bootable.

All master boot records, however, are the same whether or not the disk is bootable. When the PC is looking for a bootable disk during POST, if a disk is in the drive, the program stored in the master boot record is executed. This program tries to load the startup files of the OS. On a bootable disk, the boot record contains the names of the two hidden files. For example, for IBM DOS 3.3, the filenames of the hidden files are IBMBIO.COM and IBMDOS.COM. The program looks for these two files on the disk. If it does not find them, the disk is not bootable and a message appears, such as the following:

```
Non-system disk or disk error...Replace and strike any key
when ready...Disk boot failure
```

POST terminates until the user intervenes. Only the program in the master boot record can determine if the disk is bootable.

The File Allocation Table (FAT)

Next, the FORMAT command writes two copies of the file allocation table (FAT) to the disk. The FAT lists the location of files on the disk in a one-column table. Because the width

of each entry in the column is 12 bits, the FAT is called a 12-bit FAT or FAT 12. The FAT lists how each cluster or file allocation unit on the disk is currently used. (Remember that a cluster is the smallest unit of disk space allocated to a file.) A file is stored in one or more clusters that do not have to be contiguous on the disk. In the FAT, some clusters might be marked as bad (the 12 bits to mark a bad cluster are FF7h). These bits can be entered in the FAT when the disk is formatted or added later with the DOS RECOVER command. An extra copy of the FAT is kept immediately following the first. If the first is damaged, sometimes you can recover your data and files by using the second copy.

When the OS wants to write a file to a disk, the process works as follows. The name of the file, its size, and other attributes are written in a directory. Recall that a **directory**, in its simplest form, is a list of files on a disk. One piece of information kept in the directory concerning this file is the cluster number where the data begins (see Figure 5-6). Only the first cluster number is kept in the directory. The OS turns to the FAT to keep track of any additional clusters that are needed to hold the file.

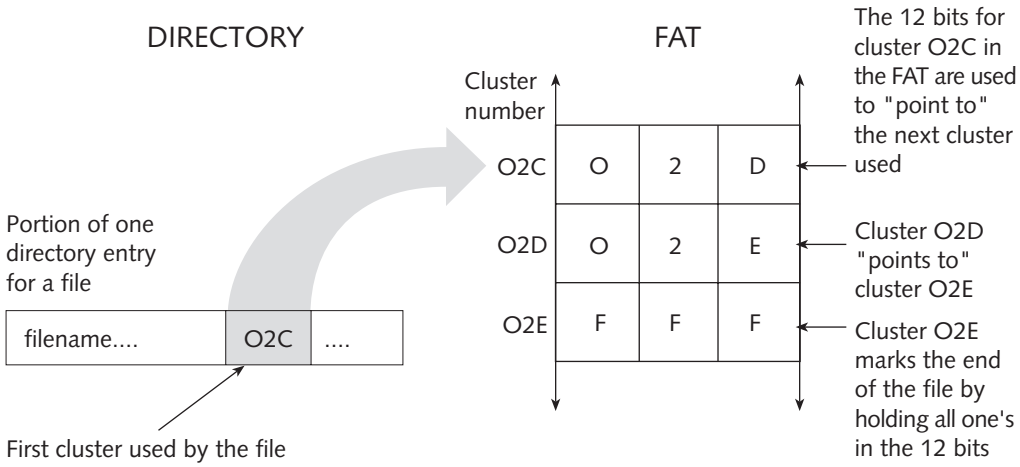

Figure 5-6 The OS keeps track of where a file is stored using a single entry in a directory and several entries in the FAT

In Figure 5-6, the beginning cluster number is 02Ch and is stored in the directory. The 12-bit FAT entry for cluster 02Ch contains 02Dh, or 0000 0010 1101 binary. This entry is interpreted as the next cluster, the second cluster, used by the file. Look in the FAT entry for cluster 02Dh to see what cluster is used next, if any. The entry in the FAT for cluster 02Dh is 02Eh, indicating that the file continues to a third cluster, 02Eh. The FAT entry for 02Eh is FFFh (binary 1111 1111 1111), the code for the last cluster used by the file. The file uses three clusters.

Figure 5-7 shows another FAT. In this example, the file contains 1,798 bytes. The file is stored beginning in cluster 4, then cluster 5, cluster 1C2, and cluster 1C3. Because this file is not stored in consecutive clusters, it is called a **fragmented file**. Recall that the beginning cluster number and the size of the file in bytes are stored in the disk's root directory. The disk is a 3½-inch high-density floppy disk, which has clusters equal to 1 sector, or 512 bytes.

Because the file is 1,798 bytes, this file requires 4 whole clusters or 2,048 bytes of disk space. The first FAT entry for the file tells you that the file starts in cluster 4. The cluster 4 table entry is 005, which points to the table entry for cluster 5. Remember that all disks have 12 bits for each FAT entry. The bits store 3 hex digits of 4 bits each. The location for cluster 5 has the hex numbers 1C2. In cluster 1C2, you see the hex numerals 1C3, which point to cluster 1C3. At cluster 1C3 you see FFF, which marks the end of the file. These four FAT entries are called a cluster chain. The **cluster chain** determines all cluster locations for a file on a disk.

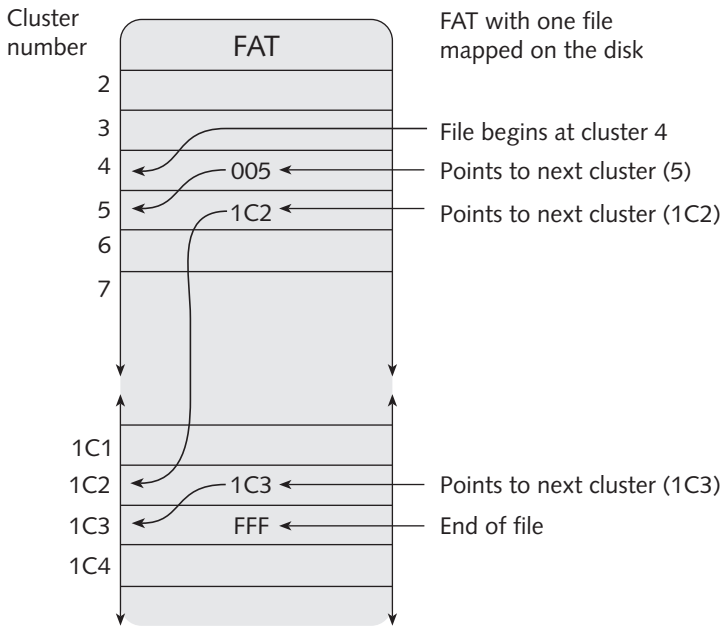

Figure 5-7 FAT with one file mapped on the disk

The Root Directory

After creating the file allocation tables, the formatting process sets up the root directory. Recall that the **root directory**, or **main directory**, is a table listing all the files assigned to this table. The root directory contains a fixed number of rows to accommodate a predetermined number of files and subdirectories; the number of available rows is dependent upon the disk type. The number of root directory entries for the four common disk types is listed in Table 5-3.

Table 5-3 Root directory entries (rows) for disk types

Disk Type	Number of Root Directory Entries
5¼-inch double-density	112
5¼-inch high-density	224
3½-inch double-density	112
3½-inch high-density	224

The root directory will later contain information about each file and subdirectory stored in it. Each directory entry is 32 bytes long, although only 22 bytes are used. Table 5-4 lists how the 22 bytes are used.

Table 5-4 Root directory information for each file

Root Directory Bytes	Usage
8	Name of file
3	File extension
1	Attribute byte (special meaning for each bit)
10	Not used
2	Time of creation or last update
2	Date of creation or last update
2	Starting cluster number in binary
4	Size of file in binary

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Notice that the root directory contains only the starting cluster number. To find out what other clusters store the file, look in the file allocation table. By dividing the size of the file by the number of bytes per cluster and rounding up to the nearest whole number, you can determine how many clusters the file occupies.

Also note that there is no place for the period (often referred to as "dot") that we normally see between the filename and the file extension in DOS command lines. The period is not stored in directories but is only used in DOS command lines to indicate where the filename ends and the file extension begins. For the long filenames in Windows 9x, more room in the directory is required. This is provided by using more than one entry in the directory for a single file, enough to accommodate the length of the filename. Both the long filename and the DOS version short filename are stored in the directory.

Time and date of creation or last update are stored in a coded form that is converted to a recognizable form when displayed on the screen. The date and time come from the system date and time, which the OS gets from the real-time clock during the boot. For DOS, you can change these with the DOS DATE and TIME commands. For Windows 9x, change the date and time in the Control Panel. The earliest possible date allowed for both is 1/1/1980.

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The file attributes are used for various purposes. One file attribute byte is broken into bits; each bit has a specific meaning. The first two bits are not used. The meanings of the other 6 bits are listed in Table 5-5, beginning with the leftmost bit in the byte and moving to the right. You can use several Windows 9x and DOS commands to change the file attributes—you'll learn about many of them later in this chapter.

The root directory and all subdirectories contain the same information about each file. Only the root directory has a limitation on the number of entries. Subdirectories can have as many entries as disk space allows. Because long filenames require more room in a directory than short filenames, assigning long filenames reduces the number of files that can be stored in the root directory.

Table 5-5 Meaning of each bit in the directory attribute byte for each file (reading from left to right across the byte)

Bit	Description	Bit=0	Bit=1
1, 2	Not used		
3	Archive bit	Not to be archived	To be archived
4	Directory status	File	Subdirectory
5	Volume label	Not volume label	Is volume label
6	System file	Not system file	Is system file
7	Hidden file	Not hidden	Hidden
8	Read-only file	Read/write	Read-only

In summary, for DOS, the FORMAT command writes tracks and sectors on the disk, and creates a master boot record, an empty file allocation table, and an empty root directory. If you include the /S option in the FORMAT line, you add the two hidden files and COMMAND.COM that together make a disk bootable. The three files are referenced in the FAT and in the root directory. The two hidden files have their file attribute bit 7, the hidden bit, set to 1 (hidden). When you make a Windows 9x rescue disk, the two hidden files and COMMAND.COM are copied to the disk to make the disk bootable.

Using DOS to Manage a Floppy Disk

You can use several DOS commands to manage a floppy disk. DOS commands are categorized according to how the command is made available to DOS. **Internal DOS commands** are part of the COMMAND.COM program and so are automatically loaded into memory when COMMAND.COM is loaded. **External DOS commands** are stored as separate program files in the DOS directory. COMMAND.COM must search for and load these program files before the command can be executed. For more information about these and other DOS commands, type HELP followed by the command name at a DOS prompt, or type the command name followed by /? (slash and a question mark).

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An external DOS command has a program file associated with it (such as FORMAT.COM), but an internal DOS command does not (for example, there is no program file named DIR.COM or DIR.EXE).

FORMAT drive: /U /V /S /Q /F:size Command

The DOS external FORMAT command discussed earlier in the chapter prepares a disk for use. If the drive is not specified, the command uses the default drive. The options for the FORMAT command are outlined in Table 5-6.

Table 5-6 DOS FORMAT command options

FORMAT Command Options	Description
/V	Allows you to enter a volume label only once when formatting several disks. The same volume label is used for all disks. A volume label is displayed at the top of the directory list to help you identify the disk.
/S	Stores the system files on the disk after formatting. Writes the two hidden files and COMMAND.COM to the disk, making the disk bootable. A bootable disk is called a **system disk**.
/Q	Recreates the root directory and FATs if you want to quickly format a previously formatted disk that is in good condition. /Q does not read or write to any other part of the disk.
/F:size	Specifies the size of a floppy disk. If the size is not specified, the default for that drive is used. The common values for size are: /F:360 is 360K, double-density 5¼-inch disk /F:1.2 is 1.2 MB, high-density 5¼-inch disk /F:720 is 720 K, double-density 3½-inch disk /F:1.44 is 1.44 MB, high-density 3½-inch disk
/U	Allows for an unconditional format of the disk, which does a more thorough job of formatting the disk by erasing all data. Use this option when you have been getting read/write errors on the disk.

LABEL Command

The LABEL command changes the volume label, or electronic name, on a disk. The volume label is stored at the beginning of the root directory and in the master boot record. Displayed at the top of the directory list when you use the DIR command, the label can be up to 11 characters long and can contain spaces.

DEL or ERASE Command

The **DEL** or **ERASE command** erases files or groups of files. Where the command does not include drive and directory information, like the following examples, DOS uses the default drive and directory when executing the command.

For example, to erase all the files in the A:\DOCS directory, use the following command:

```
C:\> ERASE A:\DOCS\*.*
```

To erase all the files in the current default directory, use the following command:

```
A:\DOCS> DEL *.*
```

To erase all files in the current directory that have no file extension, use the following command:

```
A:\DOCS> DEL *.
```

To erase the file named MYFILE.TXT, use the following command:

```
A:\> DEL MYFILE.TXT
```

UNDELETE Command

The **UNDELETE command** attempts to recover files that have been deleted. Following are some variations of the UNDELETE command.

To list the files that can be undeleted, without actually undeleting them, use the following command:

```
A:\>UNDELETE /list
```

To recover deleted files without prompting for confirmation on each file, use the following command:

```
A:\>UNDELETE /all
```

RECOVER Command

The **RECOVER command** attempts to recover a file from damaged sectors on a disk. Always specify the drive, path, and filename of the file you want to recover with the RECOVER command. If you want to recover several files, use the command on one file at a time.

To recover the file named MYFILE.TXT, use the following command:

```
RECOVER A:\DOCS\MYFILE.TXT
```

Whatever portion of the file that the RECOVER command can read is stored in the root directory and named A:FILE0000.REC (or the next available number). Copy this file to another disk before trying to recover the second file.

Because the RECOVER command might mark clusters as bad in the FAT, first use the DISKCOPY or copy command (described below) before using RECOVER. Data that might have been saved by other methods can sometimes be destroyed by the RECOVER command.

DISKCOPY Command

The **DISKCOPY command** makes an exact duplicate (sector by sector) of one floppy disk (called the source disk) to another disk of the same size and type (called the target disk).

To duplicate a floppy disk using only a single drive, use the following command:

```
C:\>DISKCOPY A: A:
```

DOS prompts you as many times as necessary to insert the source disk and then insert the target disk to make the exact copy. Data is copied from one disk to the other, byte by byte, including any hidden files, bad sectors, fragmented files, or other contents; everything is copied as is. For this reason, the copy can be faulty if the target disk has bad sectors. DISKCOPY ignores the fact that a sector is marked as bad in the FAT and copies to it anyway. The DISKCOPY command copies formatting information, so the target disk does not need to be formatted before executing the copy.

A+ OS 1.1

COPY Command

The **COPY command** copies a single file or group of files. The original files are not altered.

To copy a file from one drive to another, use the following command:

```
A:\>COPY drive:\path\filename.ext drive:\path\filename.ext
```

The drive, path, and filename of the original source file immediately follow the COPY command, and the drive, path, and filename of the destination file follow the source filename. If you do not specify the filename of the copy, DOS assigns the original name of the file. If you omit the drive or path of the source or the destination, then DOS uses the current default drive and path.

To copy the file MYFILE.TXT from the root directory of drive C to drive A, use the following command:

```
C:\>COPY MYFILE.TXT A:
```

Because a drive or path is not indicated before the filename MYFILE.TXT, DOS assumes the file is in the default drive and path.

To copy all files in the C:\DOCS directory to the floppy disk in drive A, use the following command:

```
C:\>COPY C:\DOCS\*.* A:
```

To make a backup file named SYSTEM.BAK of the SYSTEM.INI file in the \WINDOWS directory of the hard drive, use the following command:

```
C:\WINDOWS> COPY SYSTEM.INI SYSTEM.BAK
```

If you use the COPY command to duplicate multiple files, the files are assigned the names of the original files. When duplicating multiple files, no filename can be listed in the destination portion of the command line.

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XCOPY /M Command

The **XCOPY command** is more powerful than the COPY command. It follows the same general command-source-destination format as the COPY command, but it offers several more options, as outlined next, with a couple of useful examples.

Use the /S option with the XCOPY command to copy all files in the directory \DOCS, as well as all subdirectories under \DOCS and their files, to the disk in drive A. Use the following command:

```
C:\>XCOPY C:\DOCS\*.* A: /S
```

To copy all files from the directory C:\DOCS created or modified March 14, 1999, use the following command:

```
C:\>XCOPY C:\DOCS\*.* A: /d:03/14/99
```

DELTREE

The **DELTREE command** deletes the directory tree beginning with the subdirectory you specify, including all subdirectories and all files in all subdirectories in that tree. Use it with caution!

```
C:\>DELTREE [drive:]path
```

Using Windows 9x to Manage a Floppy Drive

Windows 9x performs similar functions to those available with DOS and Windows 3.x. A few are covered here. Floppy disks as well as files and folders on the hard drive are managed using Windows Explorer.

Format a Disk and Make a System Disk Using Windows 9x

To format a floppy disk, follow these steps.

1. Click the **Start** button on the Taskbar, point to **Programs**, and then click **Windows Explorer**. Right-click either drive A or drive B. The menu in Figure 5-8 appears.

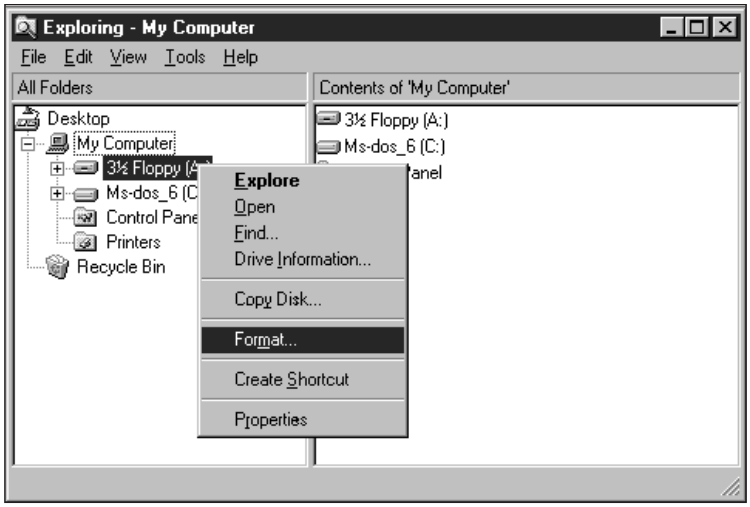

Figure 5-8 Menu to manage a floppy disk

2 Click **Format** on the menu. The dialog box shown in Figure 5-9 opens. Notice that you have three format options: Quick format (does not re-mark the tracks), Full format, or an option to copy just the system files to the disk (same as DOS SYS command).

3. Select the appropriate options to either format the disk or make the disk bootable.

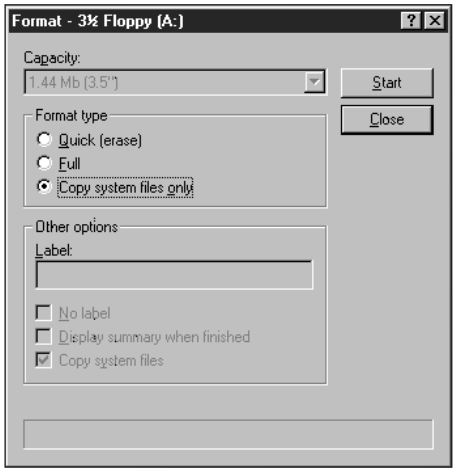

Figure 5-9 Format a disk in Microsoft Windows 9x

Copy Disk Command Using Windows 9x

If you select **Copy Disk** from the menu in Figure 5-8, a dialog box opens, as shown in Figure 5-10, where the disk listed under "Copy from" is the source disk, and the disk listed under "Copy to" is the target disk. Click **Start** to copy the disk.

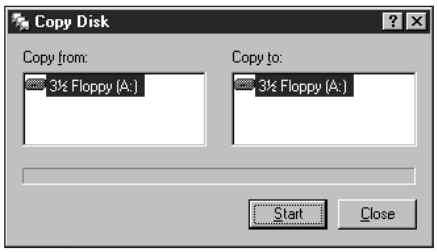

Figure 5-10 Copying a disk using Windows 9x

Emergency Startup Disks

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Although you normally boot from a hard drive, problems with the hard drive sometimes make it necessary to boot from a floppy disk. Always have a bootable disk called a **rescue disk** available for this purpose. For DOS, you must create your own disk, making sure it includes the necessary system files and any utilities (such as AUTOEXEC.BAT, EDIT.COM, and FDISK.EXE) that you might need in an emergency.

Beginning with Windows 95, the OS provided an automated method to create a system disk with useful utility programs on it. This rescue disk is called an **emergency startup disk (ESD)** and is created under the Control Panel, Add/Remove Programs group. Files that Windows 95 puts on an emergency startup disk are listed in Table 5-7, and files that Windows 98 stores on the disk are listed in Table 5-8. The use of some of these files will not be clear until Chapter 12.

The Windows 95 Emergency Startup Disk When you create a Windows 95 emergency startup disk (rescue disk), the disk is formatted and system files are copied to the disk, just as when you make a bootable system disk. In addition to the files needed to boot in Windows 95, the files listed in Table 5-7 might be copied to the rescue disk, depending on the version of Windows 95 producing the disk. The table also describes the purpose of each file.

To create the disk, click **Start**, select **Settings**, and then click **Control Panel**. In the Control Panel, double-click **Add/Remove Programs**. When the Add/Remove Program Properties window appears, click the **Startup Disk** tab and then click **Create Disk**.

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Table 5-7 Emergency startup disk files created in Windows 95

File	Purpose
IO.SYS	Used to boot DOS
MSDOS.SYS	Startup configuration information
COMMAND.COM	Provides a DOS prompt
ATTRIB.EXE	Changes the attributes of a file
CHKDSK.EXE	Determines the status of a disk and repairs it
EDIT.COM	DOS Editor
EDIT.HLP	Help for EDIT.COM
FC.EXE	Compares files
FDISK.EXE	Used to partition a hard drive (covered in Chapter 6)
FORMAT.COM	Formats a floppy disk or hard drive
MEM.EXE	Displays information about memory
MORE.COM	Paginates the results of a command on screen
MSCDEX.EXE	CD-ROM driver
MSD.EXE	System diagnostics utility
SCANDISK.EXE	Checks and repairs hard drives
SCANDISK.INI	Initial parameters for SCANDISK.EXE
SETVER.EXE	Sets the DOS version for some programs
SYS.COM	Makes a floppy disk or hard drive bootable
XCOPY.EXE	Copy utility

Windows 98 Emergency Startup Disk The Windows 98 emergency startup disk contains files similar to those in the Windows 95 version. It also contains additional support for CD-ROM drives, because Windows 98 assumes that you have installed the OS from a CD-ROM and will likely need the drive to recover from a problem.

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Table 5-8 Emergency startup disk files created in Windows 98

File	Stored in Ebd.cab File	Purpose
Aspi2dos.sys		Adaptec CD-ROM drivers and supporting files
Aspi4dos.sys		
Aspi8dos.sys		
Aspicd.sys		
Attrib.exe	Yes	Manages file attributes
Autoexec.bat		Startup batch file
Btcdrom.sys		Mylex/BusLogic CD-ROM driver
Btdosm.sys		Mylex/BusLogic CD-ROM driver
Chkdsk.exe	Yes	Used to manage a disk
Command.com		DOS command interpreter
Config.sys		Startup file to load device drivers
Debug.exe	Yes	Used to examine a hard drive
Dryspace.bin		Used to manage a compressed hard drive
Ebd.cab		Cabinet file containing utility files
Ebd.sys		Identifies the startup disk to OS
Edit.com	Yes	DOS text editor
Extract.exe		Used to manage Ebd.cab
Extwrap.exe	Yes	New version of extract utility
Fdisk.exe		Partitions a hard drive (to be covered in Chapter 6)
Findramd.exe		Finds the RAM drive during startup
Flashpt.sys		Mylex/BusLogic CD-ROM driver
Format.com	Yes	Formats a disk
Himem.sys		Used to manage extended memory
Io.sys		Core OS file
Mscdex.exe	Yes	DOS utility to manage a CD-ROM drive
Msdos.sys		Information used to boot
Oakcdrom.sys		Atapi CD-ROM driver
Ramdrive.sys		Creates a RAM drive (to be covered in Chapter 6)
Readme.txt		Information to user
Scandisk.exe	Yes	Used to manage a hard drive
Setramd.bat		Used to create the RAM drive
Sys.com	Yes	Makes a disk bootable
Uninstal.exe	Yes	Uninstalls Windows 98

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Several files on the Windows 98 startup disk are compressed into a single cabinet file. A **cabinet file** has a CAB file extension and can store several files in a compressed form. Cabinet files are often used to distribute software. You can extract files from a cabinet file

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using the Extract.exe command that is included on the startup disk. To list the files that are compressed in a cabinet file, use this version of the Extract command:

```
Extract/d filename.cab
```

To extract a single file from a cabinet file, use the Extract command, specifying the name of the cabinet file and the name of the file you want to extract. For example, to extract myfile.txt from the cabinet file MYCABFIL.cab, use this command:

```
Extract MYCABFIL.cab myfile.txt
```

To extract all files in the cabinet file, use this command:

```
Extract MYCABFIL.cab *.*
```

The name of the cabinet file on the Windows 98 emergency startup disk is Ebd.cab. The files that are compressed into Ebd.cab are indicated in Table 5-8. In future chapters you will learn to use the startup disk to recover from a Windows 98 failure.

Exchanging and Supporting Floppy Drives

This section describes problems that can occur with a floppy drive and its support system, how to replace the drive, and how to add an additional floppy drive to a computer system. When a floppy drive cannot read a disk, the problem can have many causes. We cover several in detail.

Many computers today come with one 3½-inch floppy drive, a hard drive, and a CD-ROM drive. The machine might have one or two empty bays for a second floppy drive or for a Zip drive. If you don't have an extra bay and want to add another drive, you can attach an external drive that comes in its own case and has its own power supply.

Floppy drives are now so inexpensive that it is impractical to repair one. Once you've determined that the drive itself has a problem, open the case, remove the drive, and replace it with a new one. This procedure takes no more than 30 minutes, assuming that you don't damage or loosen something else in the process and create a new troubleshooting opportunity.

Using Floppy Drive Testing Software

Determining whether a drive is damaged takes only a short time if you have the proper software tools. You can use Nuts & Bolts diagnostic software, as well as MicroSystems Development Technologies, Inc.'s TestDrive at the end of the chapter. The explanation below of what the drive-testing software checks will help you solve drive problems and give you some insight into how floppy drives work. Working with floppy drive diagnostic software, you can test these criteria:

- **Azimuth skew:** Does the drive head align well with the tracks, or is it at a tangent (see Figure 5-11)?
- **Hub centering:** Does the disk wobble as it turns, or does it turn in a perfect circle?

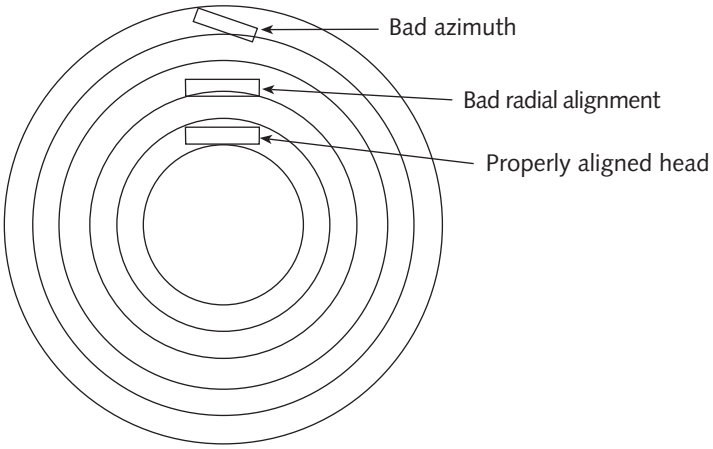

Figure 5-11 Alignment of floppy drive heads

- **Hysteresis:** Can the drive find a track regardless of the direction from which it approaches the track?
- **Radial alignment:** Is the drive head centered correctly on the track, or is it too far to the left or the right (see Figure 5-11)?
- **Rotational speed:** Does the drive turn the floppy disk at the proper speed?
- **Sensitivity:** How far from the data must the head be before it can read the data?

Over time, floppy drives can slowly shift out of alignment. A symptom of this problem is that a disk written by one drive cannot be read by another drive. To check thoroughly for these kinds of problems, the testing software must have a disk that it can use as its standard. The software determines how the drive reads the data from a disk that it knows to be written perfectly. These disks are known as **digital diagnostic disks** or **DDDs** and can be purchased at computer stores. The TestDrive software used in the end-of-chapter projects uses a DDD for several of its tests. You are asked to only complete those tests that don't require the DDD disk.

When a Floppy Disk Drive Doesn't Work

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Sometimes a problem with the floppy drive arises during POST, and BIOS displays an error message. Error messages in the 600 range occur when the floppy drive did not pass the POST test. These problems can be caused by the power supply, the drive, the controller board, or the system board.

Even if POST finds no errors, you might still have a problem. If you put a disk in a faulty drive and issue a command to access the disk, an error message such as the following might appear on the screen:

```
General failure reading drive A, Abort, Retry, Fail?
```

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If nothing happens and the computer simply stops working, the problem might have several causes, including the following:

- The application you are running is pointing to a different drive.
- DOS or Windows 9x just encountered an unrelated error that has locked up the system.
- The System BIOS or CMOS setup is not correctly configured.
- The disk in the drive is not formatted.
- The floppy drive is bad.
- The shuttle window on the floppy disk cannot open fully.
- The floppy drive controller card is loose in the expansion slot or has a bad chip.
- The cable from the controller card to the drive is damaged or poorly connected.
- The edge color on the cable is not aligned with Pin 1.
- The power supply is bad.
- The power supply cable to the drive is loose or disconnected.
- The command just issued has a mistake or is the wrong command.
- The drive latch is not closed, or the disk is inserted incorrectly.

You might discover more items to add to this list. I once helped someone with a drive error. We took the 3½-inch floppy disk out of the drive and opened the shuttle window (the spring-loaded metal cover that opens to reveal the disk inside the plastic housing) to find a blade of grass on the disk surface. We removed the grass, and the disk worked perfectly. She then remembered that she had dropped the disk in the grass. When you have any computer trouble, check the simple things first. Here are a few suggestions for solving drive problems:

- Remove the disk. Does the shuttle window move freely? Do you see any dirt, hair, or blades of grass on the disk's Mylar surface? Does the disk spin freely inside the housing cover? Some new disks simply need a little loosening up. Put the disk back in the drive and try to access it again.
- Does the light on the correct drive go on? Maybe you are trying to access drive B, but the disk is in drive A.
- Does another disk work in the drive? If so, the problem is probably caused by the disk, not the drive. The exception is when the drive is out of alignment. When it is, the drive cannot read a disk that it did not format, although it might read a disk that it formatted with its own alignment. To test this possibility, try several disks, and note whether the drive reads only those disks that it has recently formatted. If so, then you might have identified the problem, and you can replace the drive.
- Does the drive light come on? If not, the problem might be with the software or the hardware. Try to access the disk with other software. Can DOS access the drive with a simple DIR A: command? Can File Manager or Windows Explorer

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access the disk? How about using the CHKDSK A: command? If the light doesn't come on even then, the problem might involve the power to the drive or the hardware connections inside the case. Does the other drive work? If both lights do not come on, consider the power supply or the floppy drive controller card as the source of your problem.

- Does the light come on and then stay on at boot? This is most likely caused by the cable not being attached correctly to Pin 1. Check the edge color to see that it is aligned with Pin 1.
- Has this drive been used recently? Perhaps the system setup has lost CMOS data. The system might think it has a 720K drive when it really has a 1.44 MB drive. Access setup and check the drive specifications.
- Reboot the machine and try again. Many problems with computers disappear with a simple reboot. If a soft boot doesn't do it, try a hard boot.
- Try cleaning the drive's read/write heads. Use a head-cleaning kit that includes a paper disk and a cleaning solution. Follow the directions that come with the kit. You can purchase a kit at any store that sells computer supplies.
- If the drive still does not work with any disk and any software, then you must dig deeper. Inside the case, the hardware that can cause this problem is the drive itself, the data cable from the controller card to the drive, the power supply, the power cable, or the system board. To find the culprit, replace each hardware component with a known good component, one component at a time, until the problem goes away. It is helpful to have access to another working computer from which you can borrow parts.

When you are trying to discover which device is causing a problem during a troubleshooting session, you can trade a suspected device for one you know is good (called a known-good device). You can also install the device you suspect is bad in a computer system you know is working. If the problem follows the device, then you know the device is bad.

- Turn off the computer and open the computer case. Check every connection from the system board to the drive. Check the power cable connection. Remove the controller card. If the second drive works, there is a chance (but not a guarantee) that the problem is not the card or its connection. Using a clean white eraser, clean the edge connector and reseat the board.
- Take the power cable from the second working floppy drive and put it on the nonworking one to eliminate the power cable as the problem.
- Replace the data cable and try the drive again. Make sure to align the cable correctly with Pin 1. Exchange the controller card. If that does not work, exchange the drive itself and try again.
- If the drive still does not work, suspect the system board or the ROM BIOS on the system board.

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Some Common Error Messages and Their Meanings

Here are some common error messages that might be caused by problems with a floppy drive, together with what they mean.

```
Non-system disk or disk error. Replace and strike any key
when ready.
```

This message says that you are trying to boot from a disk that is not bootable. Remove the disk from the drive and press any key. The computer bypasses the floppy drive and loads the OS from the hard drive. If you intended to boot from the floppy drive, such as to boot DOS, the disk should have been formatted with the /S option, or you should have used the SYS command to place the two hidden DOS system files on the disk with COMMAND.COM. These three files are necessary to load DOS. To boot from a rescue disk in Windows 9x, first create the rescue disk as described earlier in the chapter.

If you had no disk in the floppy drive, you can assume that some of your critical OS files are missing from the hard drive. In this case, boot from a bootable floppy disk or rescue disk, and check whether the files have been erased accidentally from your hard drive.

```
Invalid or missing COMMAND.COM
```

This error appears when DOS is loading and the two hidden files are present, but COMMAND.COM is not present or is corrupt. Boot from a bootable disk that has COMMAND.COM and then copy the file to the disk that you want to be bootable.

```
Incorrect DOS version
```

This message appears when you try to use a DOS command such as FORMAT or BACKUP. Remember that these are external commands in DOS because they require a program to execute that is not part of COMMAND.COM. DOS contains a number of programs that reside on the hard drive in a directory named \DOS or, in the case of Windows 9x, in a directory named \Windows\Command. When you type the FORMAT or BACKUP command, you are executing these programs. DOS knows which version of DOS these programs belong to and the error message indicates that the FORMAT or BACKUP program you are using does not belong to the same version of DOS that you have loaded. To determine the version of DOS currently loaded, use the VER command.

```
Invalid Drive Specification
```

You are trying to access a drive that the OS does not know is available. For example, the error might appear in this situation: During booting, an error message indicates that BIOS cannot access the hard drive. You boot from a floppy disk in drive A and see an A prompt. You then try to access drive C from the A prompt, and you see the above message. DOS or Windows 9x is telling you that it can't find drive C because it failed the test during POST. As far as the OS is concerned, the hard drive does not exist.

```
Not ready reading drive A:, Abort, Retry, Fail?
```

This message means the floppy disk in drive A is not readable. Perhaps the disk is missing or is inserted incorrectly. The disk might have a bad boot record, errors in the FAT, or bad sectors. Try using Nuts & Bolts or Norton Utilities to examine the disk for corruption.

```
General failure reading drive A:, Abort, Retry, Fail?
```

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This message means the floppy disk is badly corrupted or not yet formatted. Sometimes this error means that the floppy drive is bad. Try another disk. If you determine that the problem is the disk and not the drive, the disk is probably unusable. A bad master boot record sometimes gives this message.

```
Track 0 bad, disk not usable
```

This message typically occurs when you are trying to format a disk using the wrong disk type. Check your FORMAT command. Most manufacturers write the disk type on the disk. If you have a 3½-inch floppy disk, you can tell if you are using a high-density or double-density disk by the see-through holes at the corners of the disk. The high-density disk has holes on two corners; the double-density has a hole on only one corner. Don't try to format a disk using the wrong density.


```
Write-protect error writing drive A:
```

The disk is write-protected and the application is trying to write to it. To write to a 3½-inch floppy disk, the write-protect window must be closed, meaning that the switch must be toward the center of the disk so that you cannot see through the write-protect hole. To write to a 5¼-inch floppy disk, the write-protect notch must be uncovered.

If you have a damaged floppy disk, you can probably recover most, if not all, of the data on the disk, especially when you understand how the data is stored and have the right tools for the job. These data recovery techniques are covered in Chapter 7.

Replacing a Floppy Drive

A+CORE 1.2, 1.7

Following is a five-step summary of how to replace a floppy drive. Each step is described in more detail below:

1. Check that the computer and other peripherals are working. Can you boot to the hard drive or another floppy drive? You should know your starting point.
2. Turn off the computer and remove the cover.
3. Unplug the data cable and power cable from the old drive. Unscrew and dismount the drive.
4. Slide the new drive into the bay. Reconnect the data cable and power cable.
5. Turn the computer on and check the setup. Test the drive. Turn the computer off and replace the cover.

Now let's look at each step in detail.

Check that the computer and other peripherals are working. Can you boot to the hard drive or another floppy drive? You should know your starting point. Imagine yourself in the following situation. You are asked to install a floppy disk drive in a computer. You remove the cover, install the drive, and turn on the PC. Nothing happens. No power, no lights, nothing. Or perhaps the PC does not boot successfully, giving errors during POST that appear to have nothing to do with your newly installed floppy drive. Now you don't know if you created the problem or if it existed before you started. That is why you check

A+CORE 1.2, 1.7

the computer before you begin and make sure you know what's working and not working. The extra time is well worth it if you face a situation like this.

Here is a suggestion for a quick system check of a PC that you should do before you start to work:

- Turn on the computer and verify that it boots to the OS with no errors.
- For DOS systems with Windows 3.x, enter Windows 3.x to be sure it works well.
- Using Windows 3.x or Windows 9x, open a program and perform a task from the program.
- Get a directory listing of files on a floppy disk and a CD-ROM.
- For DOS with Windows 3.x, exit Windows and run the CHKDSK command.
- For Windows 9x, do a ScanDisk.

Turn off the computer and remove the cover. As you learned in Chapter 3, guard the computer against static electricity by using a ground bracelet, working on a hard floor (not on carpet), and grounding yourself before you touch any components inside the case. *Never* touch anything inside the case while the power is on. Remove the cover and set its screws aside in a safe place.

Next, prepare to remove the power cable. The power supply cable is a four-pronged cable that attaches to the back of the drive as in Figure 5-12. The cable can be difficult to detach because the connection is very secure. Be careful not to apply so much pressure that you break off the corner of the logic board. Steady the board with one hand while you dislodge the power cable with the other.

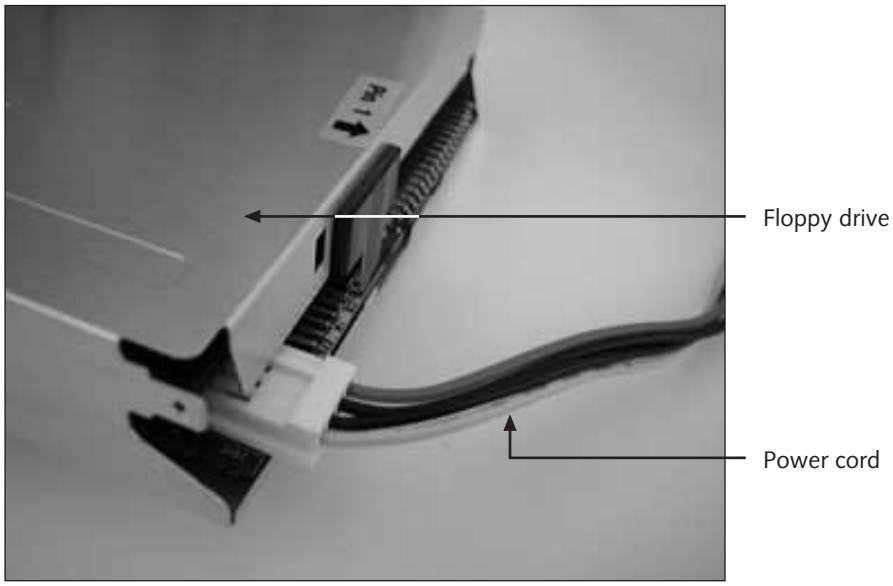

Figure 5-12 Power supply connection on the back of the drive (note how well this drive manufacturer has labeled Pin 1 on the data connection)

A+CORE 1.2, 1.7, 1.4

Unplug the data cable and power cable from the old drive and unscrew and dismount the drive. Before removing the cables and the drive, note carefully how they are assembled to help you reassemble later. The data cable might go to an adapter card or directly to the system board. Before removing the cable, note that the cable has a color or stripe down one side. This edge color marks this side of the cable as pin 1. Look on the board to which the cable is attached. Verify that pin 1 or pin 2 is clearly marked either by a number embossed on the board or by a square solder pad on the bottom of the circuit board and that the colored edge is aligned with pin 1 on both the board and the drive. Sometimes pin 1 on the floppy drive is marked, and sometimes the drive housing is constructed so that the cable built for the drive inserts in only one direction. Note the position of pin 1 on the drive.

Look at the cable connecting drive A to the floppy drive controller card or to the system board. There is a twist in the cable. This twist reverses these leads in the cable, causing the addresses for this cable to be different from the addresses for the cable that doesn't have the twist. The cable with the twist determines which drive will be drive A (see Figure 5-13). This drive is always the one that the startup BIOS looks to first for a bootable disk, unless a change has been made in CMOS setup, instructing startup BIOS to look to a different drive. By switching the cable with the twist with the cable without the twist, you exchange drives A and B. Some computers have two drives attached to the same cable. In this case, the drive attached behind the twist is drive A, and the one attached before the twist is drive B. After you are familiar with the cable orientation and connection, remove the cable from the floppy drive.

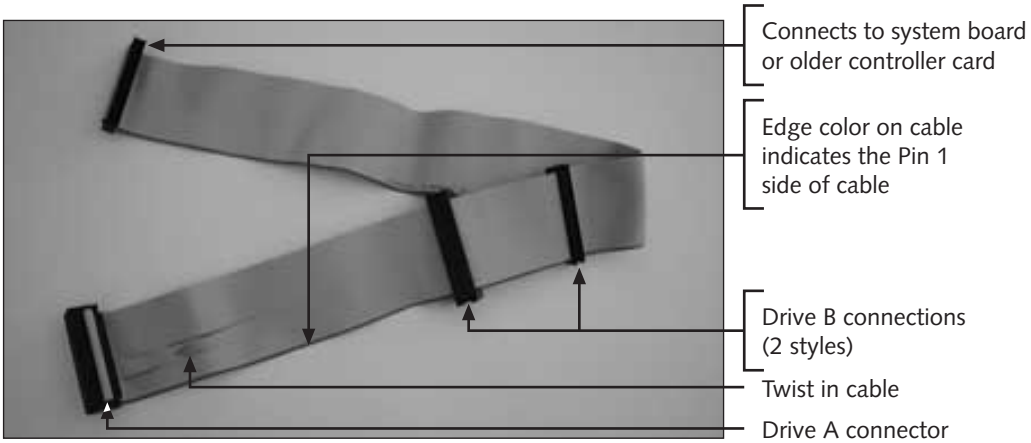

Figure 5-13 Twist in cable determines which drive will be drive A

A+CORE 1.2, 1.7

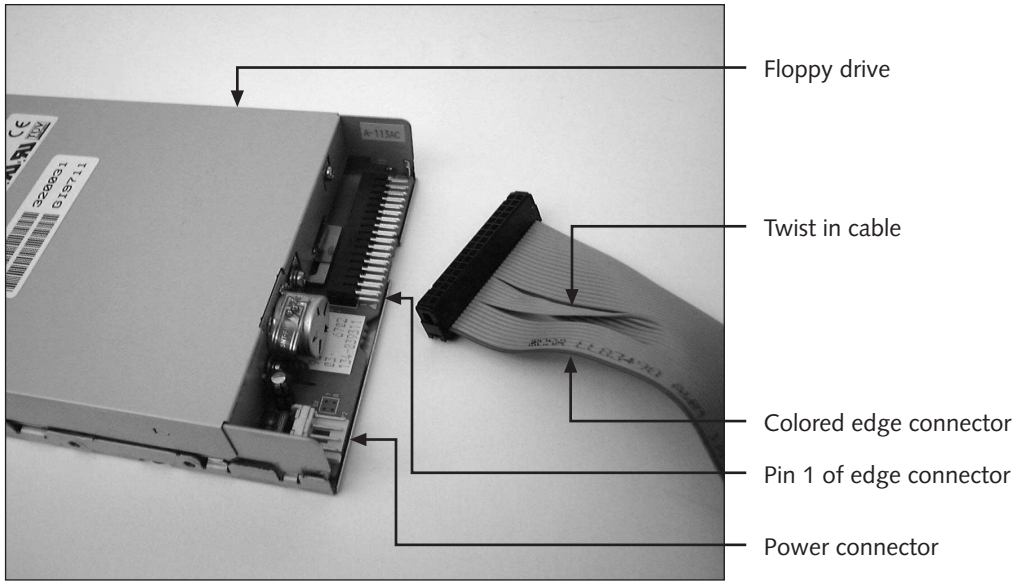

Figure 5-14 Connect colored edge of cable to Pin 1

Now that the cables are detached, you can remove the floppy drive. Some drives have one or two screws on each side of the drive attaching the drive to the drive bay. After you remove the screws, the drive usually slides to the front and out of the case. Sometimes you must lift a catch underneath the drive as you slide the drive forward. Be careful not to remove any screws that hold a circuit card on top of the drive to the drive housing; all this should stay intact.

Slide the new drive into the bay. Reconnect the data cable and power cable. If the new drive is too narrow to fit snugly into the bay, you can buy an adapter kit with extensions for narrow drives that allow them to reach the sides of the bay. Screw the drive down with the same screws used on the old drive. You might have difficulty reaching the screw hole on the back of the drive if it is against the side of the case. Make sure the drive is anchored so that it cannot slide forward or backward or up or down even if a user turns the case on its side (as many users do).

Next you reconnect the data cable, making sure that the colored edge of the cable is connected to the Pin 1 side of the connection, as shown in Figure 5-14. Most connections on floppy drives are oriented the same way, so this one probably has the same orientation as the old drive. The power cable goes into the power connection only one way, so you can't go wrong here.

A+CORE 1.2, 1.3, 1.4

Turn the computer on, check the setup, and test the drive. Double-check all connections and turn on the computer. If you changed disk types, you must inform CMOS setup by accessing setup and changing the drive type. Test the drive by formatting a disk or doing a DISKCOPY. If you determine that all is well, replace the cover and you're done.

A+CORE 1.2 Note that you can run the computer while the cover is off. If the drive doesn't work, having the cover off makes it easier to turn off the computer, check connections, and try again. Just make certain that you don't touch anything while the computer is on. Leaving the computer on while you disconnect a cable and connect it again is very dangerous for the PC and will probably damage something.

Adding a New Drive

Adding a new drive is no problem if you have an empty bay, an extra power cable, and an extra connection on the floppy drive data cable. Slide the drive into the bay, screw it down, connect the cable and power cable, change setup, and you're done.

Let's consider the problems that might occur. If you don't have an extra power cable, you can use a "Y" splitter on the power cable for the existing floppy drive to provide the power connection. Most computers have only a single floppy drive cable with two connectors on it: one at the end of the cable and one in the middle.

In either case, look for the twist in the cable shown in Figure 5-14 and install the twist so that drive A is the top drive in the bay. In most cases, orient the drives so that drive A is on the left or on the top, and drive B is on the right or on the bottom. Though the computer really doesn't care where the drives are located; it's looking only for the twist in the cable, it's easier for you to have them placed this way. If you have A and B drives, you can exchange the drives to be B and A simply by exchanging the data cable connections.

Removable Drives

Using a removable drive provides several advantages: (1) It increases the overall storage capacity of a system, (2) makes it easy to move large files from one computer to another, (3) serves as a convenient medium for making backups of hard drive data, and (4) makes it easy to secure important files. (To keep important files secure, keep the removable drive in a safe when it is not being used.) A removable drive can be either an external or internal drive.

When purchasing a removable drive consider how susceptible the drive is when dropped. The **drop height** is the height from which the manufacturer says you can drop the drive without making the drive unusable. Also consider how long the data will last on the drive. The **half-life** (sometimes called life expectancy or shelf life) of the disk is the time it takes for the magnetic strength of the medium to weaken by half. Magnetic media, including traditional hard drives and floppy disks, have a half-life of five to seven years, but optical media such as CD-ROMs have a half-life of 30 years.

An internal removable drive should also be Plug and Play compliant, meaning that the drive can interface with Plug and Play BIOS and with Windows 9x and Windows 2000 installations without having to set switches and jumpers manually.

High-capacity Disk Drives

The Iomega 3½-inch Zip drive stores 100 MB or 250 MB of data on each of its disks and has a drop height of 8 feet (See Figure 5-15). An internal 100-MB Zip drive costs less than $100 and uses an IDE interface. An IDE interface is a way for a storage device to connect to a computer system and is covered in detail later. The external Zip drive plugs into the parallel port, a USB port, or a SCSI port. The drive and disk look like a traditional 3½-inch floppy disk drive and disk, but the disk is slightly larger. If you include a Zip drive on a new PC, consider it an add-on, not a replacement for the standard 3½-inch disk drive.

Another removable drive technology is SuperDisk LS-120 (laser servo 120 MB), developed by Imation. The disk holds 120 MB of data and is backward compatible with double-density (720K) and high-density (1.44 MB) floppy disks. The SuperDisk is really two disk drives in one. It can use the old technology to read from and write to regular floppy disks, and it can use laser technology to read/write 120 MB. SuperDisk is up to 27 times faster than regular floppy drives. One advantage SuperDisk has over Zip drives is its backward compatibility with regular floppy disks. SuperDisk drives can be purchased as external (parallel port and USB) or internal drives for about $150.

Figure 5-15 An internal Zip drive kit includes the IDE Zip drive, documentation, drivers on floppy disk, and one Zip disk

Hard Disk Removable Drives

The Iomega Jaz drive is one example of a magnetic media removable drive that stores 1 GB or 2 GB of data on each removable disk. Both the internal and external models use a SCSI

connection. Iomega advertises that you can back up 1 GB of data from your fixed hard drive to the Jaz drive in as little as five minutes. The drop height is 3 feet.

Installing a Removable Drive

Installing an internal removable drive is similar to installing a hard drive and is discussed in later chapters. If the external or internal drive is a SCSI drive, the SCSI host adapter must already be installed and configured. How to install a SCSI host adapter is covered in Chapter 7. Do the following to install an external removable drive:

1. Identify the connectors. Many removable drives use either the parallel port, a USB port, or a SCSI port for connection. A parallel drive has a 25-pin connector for the cable to the 25-pin parallel port on the back of the PC and another 25-pin connector for the printer cable. A SCSI drive has a 25-pin, 50-pin, 68-pin connector on the drive for the cable to the PC and another connector for the next SCSI device on the external SCSI bus. For USB, there might be a second USB connection on the device for pass-through to another USB device.
2. For a parallel device, turn off your PC and connect the parallel cable from the drive to the parallel port on the PC. If you have a printer, connect the printer cable to the printer port on the drive. Go to Step 6.
3. For a USB device, connect the USB cable to the USB port. Go to Step 6.
4. For a SCSI device, with the SCSI host adapter installed, connect the SCSI cable to the drive and to the SCSI port on the host adapter.
5. For a SCSI drive, set the drive's SCSI ID. You might also need to set the host adapter to recognize an external device. See the documentation for the host adapter.
6. Check all your connections and plug the AC power cord for the drive into a wall socket.
7. Turn on your PC and install the software. See the installation procedures in the documentation that came with the removable drive. Most often, the software is on an accompanying disk.
8. If you have problems, turn everything off and check all connections. Power up and try again.

Chapter Summary

- Floppy disks are popular because they are cheap and convenient, and are considered a standard device.
- Data is stored on floppy disks in concentric circles called tracks or cylinders. Each track is divided into sectors. Each sector holds 512 bytes of data.

- Different types of floppy disks vary according to the organization of tracks and sectors, the density at which data can be stored, and the intensity of the magnetic spot on the magnetized plastic surface of the disk.
- The smallest unit of space allocated to a file is called a cluster. On 3½-inch high-density floppy disks, 1 cluster is the same as 1 sector, which is 512 bytes.
- When a disk is formatted for use, the formatting process creates tracks and sectors and places a master boot record, file allocation table (FAT), and root directory on the disk.
- For DOS, two hidden files and COMMAND.COM must be written on a disk for it to be a system, or bootable, disk.
- DOS and Windows 9x offer similar commands to manage files on a floppy disk.
- Installing a floppy disk drive in a PC involves firmly anchoring the drive in the bay, connecting the data cable and power cable, and informing CMOS setup of the new drive.
- The computer distinguishes drive A from drive B by a twist in the data cable. The drive with the twist is drive A.
- The three most popular removable drives are Zip, SuperDisk, and Jaz drives.
- External removable drives use either a USB port, parallel port, or a SCSI port to interface with the CPU.

Key Terms

Cabinet file — A file that contains one or more compressed files, and is often used to distribute software on disk. The Extract command is used to extract one or more files from the cabinet file.

Cluster — One or more sectors that constitute the smallest unit of space on a disk for storing data (also referred to as a file allocation unit). Files are written to a disk as groups of whole clusters.

Cluster chain — A series of clusters used to hold a single file.

COPY command — A command that copies files from one location to another (for example, COPY FILE.EXT A: is used to copy the file named FILE.EXT to the floppy disk in drive A).

DEL command — A command that deletes files (for example, DEL A:FILE.EXT deletes the file named FILE.EXT from drive A).

DELTREE command — A command used to delete a directory, all its subdirectories, and all files within it (for example, DELTREE DIRNAME deletes the directory named DIRNAME and everything in it).

Digital diagnostic disk — A floppy disk that has data written on it that is precisely aligned, which is used to test the alignment of a floppy disk drive.

Directory — A DOS table that contains file information such as name, size, time and date of last modification, and the cluster number of the file's beginning location.

DISKCOPY command — A command that copies the entire contents of one disk to another disk of the same type, while formatting the destination disk so that the two will be identical (for example, DISKCOPY A: A: uses drive A to duplicate a disk).

Drop height — The height from which a manufacturer states that its drive can be dropped without making the drive unusable.

Emergency startup disk (ESD) — A Windows 9x system disk that also contains some Windows 9x diagnostic and utility files. The ESD serves Windows 9x as a rescue disk. Also see rescue disk.

ERASE command — Another name for the DEL command.

File allocation table (FAT) — A table on a disk that tracks the clusters used to contain a file.

File allocation units — *See* Cluster.

Formatting (a floppy disk) — To prepare a new floppy disk for use by placing tracks or cylinders on its surface to store information (for example, FORMAT A:). Old disks can be reformatted, but all data on them will be lost.

Fragmented file — A file that has been written to different portions of the disk so that it is not in contiguous clusters.

Half-life — The time it takes for a medium storing data to weaken to half of its strength. Magnetic media, including traditional hard drives and floppy disks, have a half-life of five to seven years.

Internal DOS commands — DOS commands whose coding is contained within COMMAND.COM and therefore are automatically loaded into memory when COMMAND.COM is loaded.

Master boot record (MBR) (of a floppy disk) — The record written near the beginning of a floppy disk, containing information about the disk as well as the startup operating system programs.

Read/write head — A sealed, magnetic coil device that moves across the surface of a disk either reading or writing data to the disk.

RECOVER command — A command that recovers files that were lost because of a corrupted file allocation table.

Removable drives — High-capacity drives, such as Zip or Jaz drives, that have disks that can be removed like floppy disks.

Rescue disk — A floppy disk that can be used to start up a computer when the hard drive fails to boot. Also see Emergency startup disk.

Root directory — The main directory on a disk (often represented as C:\ on a hard drive), which typically contains other directories, such as Windows and MSOffice.

Sector — On a disk surface, one segment of a track, which almost always contains 512 bytes of data. Sometimes a single wedge of the disk surface is also called a sector.

System disk — A floppy disk containing enough of an operating system to boot.

Track — The disk surface is divided into many concentric circles, each called a track.

UNDELETE command — A command that resets a deleted file's directory entry to normal, provided the clusters occupied by the file have not been overwritten and the file entry is still in the directory list.

XCOPY command — A faster external DOS COPY program that can copy subdirectories (/S) (for example, XCOPY *.* A:/S).

Review Questions

1. How many sectors per track are there on a 3½" high-density floppy disk?
2. What two cables are connected to a floppy drive inside a computer?
3. What symbol is written to a disk to indicate that the track is formatted and data can be written to it?
4. What is the difference between a sector and a cluster?
5. What is another name for a cluster?
6. What is the purpose of the master boot record on a disk?
7. If a file is fragmented, describe how the entries in the FAT will look.
8. What cluster information for a file is found in the directory entry for the file?
9. Which bit in the file attribute byte tells if the file is a hidden file?
10. What is the difference between an external DOS command and an internal DOS command?
11. How can you make an exact copy of a disk if you only have one floppy drive on your computer?
12. List the steps to create an emergency startup disk using Windows 95.
13. Why is it helpful to have EDIT.COM on the startup disk?
14. If a floppy drive is not working, why is it better to replace the drive than to repair it?
15. What might cause the error, "General failure reading drive A"?
16. How can you look at a 3½-inch floppy disk and tell if it is a high-density or double-density disk?
17. What do you check if you get the error, "Write protect error writing drive A:"?
18. List the steps that you would follow to install a new floppy drive as drive B.
19. How does the computer distinguish drive A from drive B?
20. Which holds more data, a Zip drive or a Jaz drive?

PROJECTS

Unless you follow proper procedures, working inside your computer can cause serious damage—to both you and your computer. To ensure safety in your work setting, follow every precaution listed in the *Read This Before You Begin* section following this book's Introduction.

Floppy Drive Troubleshooting and Installations

1. Use a PC with A and B drives. Reverse the drives so that drive A is B and drive B is the new A. Test by booting from the new drive A. When you are finished, return the drives to their original assignments to avoid confusing other users.
2. Use a PC with only a drive A. First, verify that you can boot from drive A with a bootable disk. Then turn off the computer and open the case and examine the data cable to drive A. Look for the twist in the cable. Verify that the cable is connected to the drive so that the twist is in line. Change the cable so that there is no twist between the drive and the controller. Turn on the PC and try to boot from drive A again. Describe what happens. After you are finished, turn off the computer and restore the cable to its original position.
3. Reverse the orientation of the floppy drive cable connection to the floppy drive controller so that the edge connector is not aligned with Pin 1. Boot the PC. Describe the problem as a user would describe it. Turn off the computer and restore the cable to the correct orientation.
4. In a lab setting, practice installing a floppy disk drive in a PC by working with a partner. Turn off the computer and remove a floppy drive from your PC and replace it with the floppy drive from your partner's PC.
5. Does the ROM BIOS for your computer support an extra-high-density 3½-inch floppy disk drive? List the drive types it does support. (*Hint*: See your setup screen.)
6. Change the floppy drive type in CMOS setup for one of the floppy drives on your PC to make it incorrect. (Make sure you don't change the hard drive type accidentally.) Reboot. What error did you see? Now correct the setting and reboot to make sure all components work again.

Using Nuts & Bolts to Examine a Floppy Disk

Using the Nuts & Bolts utility on the accompanying CD, follow these directions to examine a floppy disk.

1. In Windows 9x, click **Start**, point to **Programs**, **Nuts & Bolts**, and select **Discover Pro** from the list of utilities.
2. Click the **Drives** tab.
3. On the Drives tab, click **Advanced**.
4. On the left side of the Discover Pro Advanced window, click **drive A**. Print the Discover Pro report of the disk in drive A.

Using Diagnostic Software

MicroSystems Development provides a diagnostic program called TestDrive for examining and diagnosing problems with floppy drives and floppy disks. You can find a demo version on the Web that you can download from the company's site:

www.msd.com/diags/

When you download or copy the zipped file to your PC, explode it, and then do the following. (Most of the options on the TestDrive menu require that you have a DDD disk, but you can perform a few tests without one.)

Execute the TestDrive software by double-clicking the file **TESTDRIVE.COM** in Windows Explorer. The menu shown in Figure 5-16 appears. Select the option to perform the Write/Read test. The warning box shown in Figure 5-17 appears. Perform the test with a disk that has nonessential data on it that can be erased. While the test is running, answer these questions.

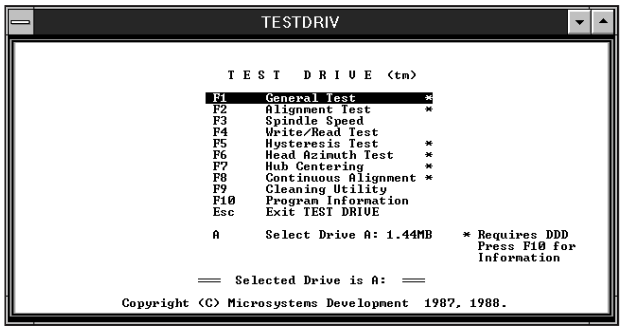

Figure 5-16 TestDrive main menu

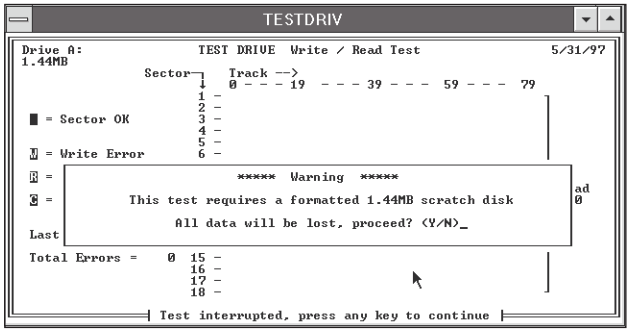

Figure 5-17 TestDrive's Write/Read Test

1. In what order are these components on the disk tested: heads, tracks, and sectors?
2. Did you get any errors? If so, where?
3. If you got a significant number of errors, try another disk. Do you see a pattern of errors when moving from one disk to another?

Troubleshooting Skills

1. Create a bootable system disk in Windows 9x. Boot from the disk. What version of the OS are you using? How can you enter Windows 9x from here?
2. Cause DOS to give you the error "Incorrect DOS version."

Working with a Cabinet File in Windows 98

1. Create a Windows 98 emergency startup disk.
2. Copy the cabinet file to a new directory on the disk.
3. Get a printed list of the files in the cabinet file.
4. Extract all files from the cabinet file into the new directory.
5. Get a printed list of the files in the new directory.

Comparing the Data Storage Cost of Devices

Research the market (using, for example, *Computer Shopper*) and fill in the following table to compare the storage costs of different secondary storage devices.

Type of Device	Zip Drive	Jaz Drive	SuperDisk
1. Manufacturer			
2. Capacity			
3. Price of drive and first disk			
4. Price of additional disks			
5. Cost per KB of drive and first disk			
6. Cost per KB of additional disks			

Using the Internet for Research

A friend of yours needs a successful way to carry very large files from one location to another location where he needs to access the files on either a Mac or a PC. You think that SuperDisk might be the technical solution, but you need to do some research. Can an external SuperDisk drive port from a PC to a Mac? If so, using what kind of connection? Use the Internet to find the answers to these questions and write a brief (less than one page) report to make your recommendation. *Hint:* See *www.superdisk.com*.